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SELECTION AND CLASSIFICATION USING A FORECAST APPLICANT POOL

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NOTICE

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A time series analysis model was developed to forecast the quality (i.e., means and standard deviations of aptitude scores) and quantity (i.e., total number of applicants) of the Air Force's future applicant pool. By forecasting future talent of applicants and their number, an approximate optimal assignment solution could be obtained even though the applicants have to be assigned one at a time. The model was developed on 258,588 subjects who had taken the Airman Qualifying Examination during 1971 to 1974. The model included trend and seasonal components and was evaluated by applying it to forecast monthly means, standard deviations, and total number of applicants. Results in terms of mean absolute deviation and squared absolute deviation scores indicated that the model could forecast within one point of the actual observed score values across two years for means and standard deviations, but not as well for total number of applicants.

PREFACE

This research was completed under Work Unit 20770401, Development of an Advanced Person-Job-Match System for Air Force Enlistees for use in the All-Volunteer Environment.

The author would like to express his appreciation to Sgt William Solomon for developing the computer program used to perform the time series analyses.

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I. INTRODUCTION

The Air Force is developing a computer based selection and classification system. This computerized system will replace the present manual system and will permit recruits to be assigned to a specific job (Air Force specialty) or to one of four aptitude areas (i.e., Mechanical, Administrative, General, or Electronic aptitude areas). Those individuals assigned to an aptitude area would subsequently, during basic training, be assigned to a specific Air Force specialty (AFS).

One of the major problems associated with this research and development effort is "how does one optimize classification when the applicant pool is unknown?" This is the problem that is apparent when a potential recruit walks into a recruiting office. He can be screened for certain mandatory requirements and be given an aptitude test and physical examination, but the pool of people with whom he is to compete for induction during that month is not known until the month has passed.

This technical report focuses on this issue and presents the results of a preliminary forecasting model of the future applicant pool.

II. OBJECTIVE

The objective of this research was to develop a forecast model of the future Air Force applicant pool. By forecasting applicants' quality (i.e., means and standard deviations of aptitude scores) and quantity, (total number of applicants) a potential enlistee could be compared to the forecasted pool and, thereby, optimization could be better approximated. The actual algorithm used to perform the optimization procedure was the Decision Index (Ward, 1959) which requires only the payoff or utility values of a given applicant for each job, and the total score values of all applicants in each job. The payoff or utility value is a number which reflects an applicant's worth on a given job.

Constraints and Goals

In developing an applicant pool forecast model certain Air Force management constraints and goals required consideration. These were that one had to be able to forecast by each month the quality and quantity of the applicant pool by sex, and aptitude area. Therefore, different equations were required for each combination of the two factors cited above. In addition, the forecast had to project the estimated pool up to seven months into the future, since recruits could be given assignments that far in advance.

Basic Model

The basic model developed was a time series analysis model, and can be stated as:

$$Y = TSCE$$

where

Y = the value to be forecasted

T = the trend value

S = the seasonal component

C = the cyclical component

E = other irregular influences not predictable.

The data used to develop the model consisted of means, standard deviations, and total number of applicants taking the Airman Qualifying Examination for entry into the Air Force during 1971 through 1974. Once these were obtained the first two years (1971–1972) were used to develop the model and then the last two years were used to test the accuracy of the model by forecasting each month over the two-year period.

The trend value (y) was obtained by fitting a least squares line during a series of months (e.g., 6 months and 12 months) to obtain the forecasted value for one month in advance (next month) and all other future months up to seven months. The seasonal component was obtained by the Ratio to Trend Method. The seasonal period used for the model was one year, therefore, differences for each month across years was obtained. The computations involved in obtaining the Ratio to Trend seasonal component involved dividing the actual observed value (i.e., mean, standard deviation, or N) by the estimated value obtained from a least squares fit for a one-year period. Then for each month across all years (i.e., 1971–1972) these are averaged in an attempt to remove chance variation. This component when multiplied with the trend value resulted in an adjusted trend value due to seasonal influence.

The cyclical component (C) is a predictable cycle which is longer than the seasonal cycle. That is, the cyclical influence would be a cycle whose duration is longer than one year. During the initial analysis of the data it was determined by plotting the data, that the cyclical component could not be predicted and therefore the model was reduced to:

$$y = TSE$$

A series of trend lines were developed. Specifically, the trend lines used to predict the next month's value were computed on the previous 3, 4, 6, 9, 12, and 18 months.

The reason for using short and long trend lines was that certain data (e.g., mechanical aptitude mean scores for males) tended to be rather stable so a long trend line (18 months) was hypothesized to be appropriate. On the other hand some data (e.g., administrative mean scores for females) appear to vary in an unpredictable long range (2–3 year cycle). In this case, a short trend line would be more sensitive to these slight changes.

As mentioned earlier there was a cyclical component but since it was not periodic it could not be accurately predicted. Therefore, when computing the seasonal component the cyclical influence can be partially removed by reducing the trend line from 12 months to 6 or to 3 months. So that for a given year if a 12-month least squares line was used then the estimate value obtained by it can be used as described earlier. However, if a 3-month line is used then there will be 4 of these required to cover the year period (i.e., 1st, 2nd, 3rd, and 4th quarters). The actual number of months evaluated for the trend estimate values for the seasonal index were 3, 4, 6, 9, and 12 months in length.

III. ANALYSIS

In order to evaluate which combination of trend and seasonal components yielded the best predictive system, a computer program was written which forecasted the future months values (one month at a time) and then computed the absolute deviations and squared absolute deviations. That is, the actual next month value minus the forecasted value gives the absolute deviation when positive and negative signs are eliminated. These were computed for males and females in each of the four aptitude areas (Mechanical, Administrative, General, and Electronics) for each month across two years (1973–1974).

IV. RESULTS

Table 1 lists the forecast results obtained using the Mechanical Aptitude mean values for males. Each cell represents the mean absolute deviation or squared absolute deviation across the years of 1973 and 1974.

Table 1. **Accuracy of Next Month's Forecast of Mean Mechanical Aptitude Indices (Males)**

Trend	3-Month Estimate AD	3-Month Estimate SQD	4-Month Estimate AD	4-Month Estimate SQD	6-Month Estimate AD	6-Month Estimate SQD	9-Month Estimate AD	9-Month Estimate SQD	12-Month Estimate AD	12-Month Estimate SQD
3-Month	.8558	1.2214	.9278	1.1988	.8300	1.1269	.9153	1.1684	.9042	1.2304
4-Month	.8138	1.1191	.8106	1.0529	.6978	.9809	.8077	1.0039	.8609	1.0938
6-Month	.7525	.9891	.7245	.9174	.7380	.9321	.7383	.8944	.8203	1.0013
9-Month	.6430	.8462	.6809	.8014	.6458	.7981	.5962	.6943	.5637	.6924
12-Month	.6779	.8467	.6707	.8034	.6662	.7916	.5483	.6465	.4698	.5913
18-Month	.7523	.8988	.7290	.8367	.6809	.7930	.5845	.7152	.5132	.6874

As can be noted, most of the mean absolute deviations and squared absolute deviations are less than one point on an aptitude score scale which ranges from the 5th percentile to the 95th percentile. Therefore, the forecast system is rather accurate in this case. This is a typical example for all forecasted mean values (i.e., for males and females in the four aptitude areas). This is also typical of the results for forecasting standard deviation scores. That is, they can be forecasted over a two-year period with an average (mean) absolute and squared absolute deviation of less than one point. This can be seen in Table 2.

Table 2. **Accuracy of Next Month's Forecast of Standard Deviations for Mechanical Aptitude Indices (Males)**

Trend	3-Month Estimate AD	3-Month Estimate SQD	4-Month Estimate AD	4-Month Estimate SQD	6-Month Estimate AD	6-Month Estimate SQD	9-Month Estimate AD	9-Month Estimate SQD	12-Month Estimate AD	12-Month Estimate SQD
3-Month	.3166	.4230	.3296	.4297	.3305	.4253	.3261	.4222	.3536	.4397
4-Month	.2944	.4058	.3085	.4042	.3009	.3969	.3028	.3986	.3113	.3998
6-Month	.2895	.3906	.3005	.3842	.2908	.3748	.2790	.3797	.2648	.3531
9-Month	.3256	.3874	.3151	.3735	.3185	.3721	.3196	.3797	.3096	.3632
12-Month	.3144	.4281	.3278	.4173	.3346	.4144	.3208	.4288	.3318	.4045
18-Month	.4556	.6065	.4653	.5941	.4608	.5903	.4527	.6050	.4516	.5857

This is not the case when the total number of applicants per month are forecasted. The accuracy in forecasting as indicated by the absolute deviation and squared absolute deviation is not nearly as good for total number of applicants as it is for their aptitude means and standard deviations. For example, in predicting an N of 6,000, this typically might be in error by 600 or more applicants. In some cases the error of predictions is even more extreme. This is an area on which future research will concentrate.

In addition, the particular combination of trend and seasonal components which produces the most accurate system, varies with the particular data forecasted (e.g., mean mechanical scores for males versus those for females). Generally, the six-month trend component with the six-month derived seasonal component provides an accurate forecasting system which is sensitive to undetermined slight cyclical changes.

V. CONCLUSION

The research data indicate that the forecast model developed provides an accurate forecasting technique for aptitude means and standard deviations. In forecasting the total number of applicants by month, the technique is less adequate and points out the need for a more complex approach for this area.

REFERENCE

Ward, J.H., Jr. *Use of a decision index in assigning Air Force personnel.* WADC-TN-59-38, AD-214 600. Lackland AFB, TX: Personnel Laboratory, Wright Air Development Center, April 1959.

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